The form of Helix prevailing in, and which may be said to be characteristic of the Quito Valley is Isomeria, peculiar to the northern portion of the southern continent. Both Bulimus and Bulimulus are essentially characteristic of South America.

The genus Orthalicus is also South American, but belongs rather to the eastern than to the western side of the continent. *Achatina magnifica*, as Pfeiffer suggests, is probably an Orthalicus. Oleacina is most numerously represented in Mexico and Central America, and the nearest adjacent islands of the West Indies. One species is said to inhabit Ecuador, but the exact locality is not given.

Clausilia is a European genus, but has representatives in Asia, and a few species of the sub-genus Nenia in South America,—one only in the West Indies, *C. tridens* Chem. of Porto Rico. Species of three operculated genera occur in the Quito Valley,—Cyclotus, Cyclophorus and Bourciera. The latter, peculiar to Ecuador, is placed by Pfeiffer, in the sub-family Realia of the family Cyclostomacea, but it would seem to belong to Helicinacea, with which, as pointed out by Troschel, its dentition agrees, although in form of shell it is allied to Realia. Cyclotus has several species in Mexico and Central America, more in South America, but forty-two species in the West Indies, of which thirty-four belong to Jamaica. It may be mentioned that half of the species attributed to the valley of Quito, occur also in New Granada.

Cyclophorus has its principal development in Asia and adjacent islands, but it is curious, as I have elsewhere noticed, that while there are a few species found in Mexico, Central and South America, seven occur in the West Indies, and all in Guadeloupe, Dominica and Martinique.

NOTES ON THE GEODES OF ILLINOIS.

BY PROF. GEORGE H. PERKINS.

Not least interesting among the many localities in the Mississippi valley that attract the geologist and mineralogist is the Illinois Geode region. This extends for twenty-five or thirty miles

along the Illinois side of the Mississippi, reaching from a short distance above Niota on the northern border of Hancock County southward beyond Warsaw; and indeed the formation in which these specimens occur reaches as far south as the mouth of the Illinois River, but by far the greater part that have been collected were obtained between Niota and Warsaw, where they occur in very much the greatest abundance. Very many fine specimens have been obtained across the river in Iowa, and the region over which they are distributed is probably larger in this state than in Illinois. So far as my own observation goes, the geodes do not occur in Illinois at any great distance from the river, nearly all the best localities being within three or four miles from the banks; but I do not speak with entire confidence in regard to this as nearly all my personal investigation has been confined to localities near the river and on the Illinois side. For this reason what may be said at this time will refer mainly to the region between Niota and Warsaw. The geodes from this region are, many of them, very beautiful, being often lined with most brilliant crystals of quartz, appearing like miniature caves lined with diamonds, or, less brilliant but more exquisite, some are lined with a frost-work of small white crystals of the same substance, or with satin crystals of calcite and pearl spar. They are imbedded in a soft, brittle, argillaceous shale, which is sometimes a little calcareous, and in a very few instances passes into limestone, although the outer coating of the geode is always aluminous. This mass of shaly rock forms what is called the "Geode bed," a member of the Keokuk group of the Subcarboniferous age. The thickness of this bed varies in different places, but is nowhere very great. At Warsaw it is well exposed in a railroad cut, and here, according to Mr. Worthen, the thickness is forty feet. (Ill. Geol. Rep., Vol. 1. p. 335.) No trace of fossils has been discovered in the shale, but in some places thin layers of limestone are intermingled with it, and these afford the characteristic fossils of the Keokuk limestone. Whatever the inner coating of these geodes may be, the shell, or crust, is always siliceous. The outer surface, however, is usually coated with the same clay-like material as that which composes the shale in which they occur. Very often there is an outer layer of siliceous clay which forms a part of the crust and sends out numerous sharp, irregular projections into the next layer which is, probably always, chalcedony. It should be remembered that these,

and other not yet mentioned "layers" of the crust are so called more for convenience, than because they exist sharply defined in every specimen, for such is not the case; in most they shade into each other by almost imperceptible degrees. The outer surface is generally light colored — either yellow, or drab, or yellowish brown; but when there is much oxide of iron present the color deepens to chestnut brown. The general form of the geodes is more or less spherical and in a majority of the specimens it is quite regularly so, but the character of the interior seems to have some influence in shaping the whole mass. In my own collecting, at least, it has uniformly been true that those geodes that contained only quartz were most regular in form and those lined with crystallized quartz are rather more regular than those lined with chalcedony. Those specimens that contain oxide of iron are often quite flat, as are those with calcite, though these latter are usually flattened more on one side than on the other and in various ways made irregular.

Although sometimes packed almost as thickly as possible in the shale, the geodes are for the most part entirely distinct from each other; but sometimes two or more are found adhering to each other, either two of nearly equal size forming a dumb-bell shaped mass, or, more commonly, a large one is surrounded by several much smaller. These are not often so firmly attached that a sharp blow will not separate them entire. When broken these smaller geodes are usually solid. Sometimes small, pocket-like geodes are found in the crust of large and heavy ones, and sometimes these extend so far over the surface that the geode becomes like a ball coated outside and in with crystals, with occasionally a thin clayey crust over a part of the outside.

The geodes are not exactly alike in different portions of the region. In some places nearly all are small, while large ones are not infrequent in others, in one place most are regular spheres, in another most are quite irregular, in some parts of the bed they lie so thickly as to crowd each other, in other parts they are far apart. Not only do these and similar differences occur in places at some distance from each other, but in the same place upper, lower or middle portions of the bed may differ widely in the number, form, size and contents of the geodes. Everywhere many of the geodes are solid, and the first thing for a collector to learn is to judge by the weight of any given specimen whether it

is solid or hollow, and also how hard a blow is needed to break it open, if he finds it light enough to be hollow; for a heavy blow, such as is necessary to crack a thick crust, would dash a thinner one into small fragments. Those large geodes that contain much calc spar are usually solid, while those that are smaller and lined with small crystals of this material are frequently quite hollow. The quite large specimens are more apt to have thick walls, or to be entirely solid, than those of less size whatever the filling. The cavity of a geode does not often correspond with the exterior, as the walls are constantly varying their thickness. Many are lined with a single, plain layer of crystals, others have this crystalline surface raised in rounded prominences, some of them long and cylindrical, others low and mound-like. In some, besides the lining there is a partition, extending across the cavity, lined with crystals on both sides. Rarely, the collector may find a thin crust lined with small bright crystals, within which is a hollow ball, but little larger than the cavity and attached at one or two points to the side, covered with somewhat smaller crystals. So, in innumerable ways do we find these singular objects varied and, as the outside gives little or no indication of the inside, the charm of uncertainty is added to the excitement and pleasure of the collector. So far as my own experience goes those specimens that are from one to three inches in diameter are least likely to be solid, though very fine ones may be obtained six or even ten inches in diameter without great difficulty. The range in size is quite large, as very pretty specimens not over half an inch in diameter may be found, while the largest I have seen were fully eighteen inches across the broken halves. But these larger geodes, aside from being very scarce, are not very desirable acquisitions as they are very heavy, weighing fifty pounds or more in the best examples. The geodes are most abundant, and hence most easily collected, in the beds and along the sides of those streams which intersect the geode bed, as nearly all those around Hamilton and Warsaw do. The geodes are dislodged from their resting place by high water, frost, etc., and are carried down by the streams, so that near the mouth, or in a basin, the ground is often paved with them, but good specimens are not rare along the sides of the streets, in cuts, or wherever the earth has been washed or dug in the neighborhood of the bed in which they lie. Few things are more unpromising or unattractive than a geode when first taken

from its cavity in the rock, and unless its regular form caught the eye, it would be passed without a second glance as wholly undeserving of notice. A mere ball of clay would possess fully as much elegance. But pick up that dull, dirty-looking ball, and, if it be a good specimen, its extreme lightness attracts attention and excites curiosity, and now the impulse is to see what there is inside. A few strokes of the hammer and it breaks in halves, and as it falls apart lo! what wonders are presented to us! Who would have imagined that so uncouth and rough an exterior concealed such a splendid interior,—a crystal grotto, which flashes and sparkles when the sunlight strikes it as if made of gems of the first water. The geodes contain quite a number of different minerals which are very variously arranged in different specimens.

Some of these minerals have been already alluded to, but they deserve a somewhat fuller treatment. As all the geodes are siliceous on the outside, so by far the most common variety is that composed wholly, or nearly so, of quartz. The structure of these is almost invariably as follows; first, the outer, earthy coating; second, a thin layer of white or whitish chalcedony; third, a layer of clear quartz more or less granulated; and fourth, a layer of crystalline quartz, with simple, pyramidal terminations lining the inside. The granular layer does not always extend around the entire sphere, but often the crystalline quartz rests directly on the chalcedony, and in some there is scarcely any or no granulated appearance, but it is present in most that have come under my notice. The crystals of the inner layer are usually clear and colorless, but many times they will be tinged a more or less deep yellow by oxide of iron, and a few crystals have been found lying detached in the cavity of the geode, so bright a yellow as to cause them to resemble the topaz very closely, and some have been cut and sold as topazes. Not infrequently the crystals have a slight bluish tinge which, instead of the brilliant white lustre, gives them a soft and liquid hue, as if just ready to melt into purest water. Crystals of smoky quartz are occasionally found, and I once had the good fortune to break a rather clumsy specimen about three inches by four inches in size, the inner coating of which was rose quartz. Instead of a simple layer of crystals, either plain or variously convoluted, specimens are not uncommon in which the crystals, many of them doubly terminated, are piled upon each other in all directions, and sometimes these clusters are

loose in the cavity, or the latter may be filled with single crystals, often so small as to appear like fine sand. The crystals are not always clear, but may be covered with a layer of chalcedony sometimes so thin as not to modify the form of the terminations, sometimes thick enough to make a papillose surface. This coating may be either light blue, flesh color, yellowish white, or a bluish opal-white, all of them appearing semi-transparent or of an opaque, chalk white. Many of this last color have the crystalline terminations so modified as to appear cubical. In a few very beautiful specimens that I have seen, a clear white chalcedonic surface was sprinkled all over with small, perfectly colorless crystals, looking like fine dew drops on a white flower. This coating becomes thicker and thicker, until all trace of the crystals is lost, and then we have a layer of chalcedony with a perfectly smooth botryoidal or mamillary surface, outside of which is a layer of crystalline quartz, then, usually, a granulated layer and then the outer chalcedony layer. The inner layer is sometimes very thick, being twice the thickness of all the rest.

The color of the chalcedony is most often a reddish purple, but not very seldom we find a greenish yellow or bluish white and rarely a chalk white. In rare cases there are two layers of different color, such as pure white over dark brownish purple. In a few cases the surface of the chalcedony is sprinkled with crystals of pyrites or other substances, but yet the geodes afford a marked contrast in this respect to those lined with crystalline quartz, for while the former are remarkably free from what might be termed foreign substances and never, so far as I have seen, is any considerable part of the cavity filled with them, in the latter variety we find, resting upon the quartz, all the different minerals found in the geodes, and often two or three together nearly filling the cavity. Besides the isolated crystals of calcite and dolomite found resting on the quartz crystals, we have some in which the lining is made up entirely of one or the other of these substances. Like all the rest these are siliceous on the outside. In the calcite geodes the crystals are usually small and of rhombohedral form, which is often obscured by their crowding together or piling upon each other. In color they differ, some being colorless and transparent, many white, or yellowish, or flesh color, and some few dark purple or chestnut brown, and in one case a layer of dark brown crystals was ornamented with here and there a cluster of pure white ones. Two or more forms of crystallization may occur

one upon the other in the same specimen, as, for example, a scalenohedral crystal resting upon differently modified rhombohedrons. Sometimes the cavity of the geode is filled with a mass of white or, rarely, flesh colored calcite. Isolated crystals, or groups of crystals of pearl spar or dolomite, are of quite common occurrence both in the quartz and calcite geodes, but a complete layer of this mineral is less common. The crystals are generally quite large as compared with the size of the geode.

According to Prof. Brush (Ill. Geol. Rep., Vol. 1, p. 91), this dolomite contains "a large per cent. of carbonate of iron with the carbonates of lime and magnesia." Although the usual color of the dolomite is either a light yellowish brown or silvery gray of different shades, it is often stained a rusty brown by oxide of iron.

The collector will once in a while meet with a geode, probably of quite small size, filled with a fine white powder. Prof. Brush states this to be a "hydrous silicate of alumina." The only metals thus far found in the geodes are iron and zinc. The iron occurs in the form of oxide, in small crystals and in powder; one geode about one and a half inches in diameter lined with small quartz crystals was filled with the powdered oxide. Besides this, long, slender, hair-like crystals of pyrites occur as well as those of cubical form. These are scattered over chalcedony, quartz crystals and calcite, and are also imbedded in the calcite. Zinc blende is quite common occurring either in crystals, some of them quite highly polished, or in a mass in the centre of solid geodes when it is associated with calcite.

In the northern part of Hancock county a few geodes, all that I have seen being lined with quartz crystals, contain asphaltum. Prof. Brush describes one of these as "apparently more than half filled with asphaltum, breaking with a clear conchoidal fracture, having a high lustre and jet black color and containing imbedded in it detached crystals of quartz" (Ill. Geol. Rep., Vol. 1, p. 92). This was four by three inches in size. Instead of asphaltum some are filled with petroleum. Besides those minerals enumerated, Prof. Brush reports finding in a very few cases minute crystals of gypsum and in one of arragonite. Water is found in some of the geodes which is bitterish to the taste, and contains, according to Prof. Brush, a small per cent. of the sulphates of lime and magnesia and a slight trace of silica. As the crust of the geodes is wholly impervious to water, this must have been inclosed when the crust was formed. As Mr. Worthen remarks

it is worthy of notice that, while the geodes are always surrounded by material rich in alumina, no crystallized forms of this mineral have yet been discovered in them. Geodes of fine quality occur in Missouri, and Prof. White reports calcareous geodes, some of them entirely free from silica, in a soft magnesian lime-stone, in North Eastern Iowa.

Any one who for the first time sees a fine geode and notes its regular form, its uncouth exterior and brilliant interior is sure to ask "How was it made?" The more specimens he sees the more is his curiosity excited, and if he visits the locality and sees them *in situ* his wonder and interest increase to the highest pitch. There are very many difficulties to be overcome in trying to account for the presence of the geodes and their formation, and it may be only presumption to attempt that which so many skilful mineralogists have passed in silence. However, a careful study of the geodes, both in cabinets and in their native bed, has convinced me that they must have been formed in some such manner as that here presented. What now constitutes the geode bed, was at one time a mass of plastic clay filled with siliceous and calcareous fluids. That it was plastic is shown by facts obvious to any one who has ever visited the locality. If now this mass were acted upon by steam or some other vapor, or gas, as dough is acted upon by carbonic acid, it would like the dough be filled with cavities of all sizes of a more or less spherical form, and irregularly distributed through the mass. Into these cavities the solutions of silica etc. would filter and in some cases crystallize, in others simply deposit the solids held in solution, according to circumstances. The form, arrangement, etc., of the various substances would be determined, I suppose, by their densities and the laws of crystallization. After all the materials had hardened, the soft brittle clay would easily separate from the harder filling of the cavities and this would then fall out shaped by the mould in which formed.

REVIEWS.

THE PEABODY MUSEUM OF AMERICAN ARCHÆOLOGY AND ETHNOLOGY.*—The fourth annual Report contains much that is of gen-

*Fourth Annual Report of the Trustees of the Peabody Museum of American Archæology and Ethnology. Boston, 1871. 8vo. p. 27.